

09/868880

Attorney Docket No. DEXNON/110/PC/US**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE (DO, EO/US)**

International Application No.

PCT/GB99/03485

International Filing Date:

10/21/1999

Title: NONWOVEN FOR POLYMER  
MOULDING APPLICATIONS

Applicant(s) For United States

Colin BEVERIDGE and Gilbert LANIER

Commissioner For Patents  
Washington, DC 20231

Sir:

Please commence the United States National Processing of the above-identified international application.

**WE HEREBY REQUEST IMMEDIATE EXAMINATION UNDER 35 U.S.C.****371(F).**

The following items are enclosed:

- (1) A check in the amount of \$729.00 to cover the national fee, which has been calculated as follows:

Basic Fee	\$ 690.00
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Independent claims in excess of 3; (1X 39)	39.00
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Claims in excess of 20; (0 X 18):

No multiple dependent claims presented:

TOTAL	<u>\$ 729.00</u>
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- (2) unsigned Inventors' Declaration.
- (3) Preliminary Amendment to the above International Application.

Attorney Docket No. DEXNON/110/PC/US

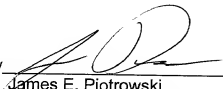
If the amount enclosed is incorrect, please charge or credit the difference to  
Deposit Account No. 16-2563.

The Commissioner is hereby authorized to charge any additional filing fees  
which may be required to complete the requirements for national processing of the  
above-identified international application to Deposit Account 16-2563.

Respectfully submitted,

COLIN BEVERIDGE et al

By

  
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#6

In re patent application of  
Colin BEVERIDGE and Gilbert LANIER

J003 Rec'd PCT/PTC

1. 8 JAN 2002

International Application No. PCT/GB99/03485  
International Filing Date: 10/21/1999  
United States Application No. 09/868,880

For: NONWOVEN FOR POLYMER MOULDING APPLICATIONS

Box PCT  
Commissioner For Patents  
Washington, D.C. 20231

Sir:

RESPONSE TO NOTIFICATION OF MISSING REQUIREMENTS

This is in response to the Notification Of Missing Requirements Under 35 U.S.C. 371, mailed  
October 12, 2001, copy attached.

The signed Inventor's Declaration is submitted herewith. Also enclosed is a check for \$130.00 to  
pay the Surcharge for late filing of the Declaration.

It is hereby petitioned that any required extension of time be granted for filing the missing  
requirements. Please charge any required extension fee to Deposit Account 16-2563.

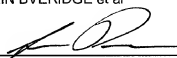
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☒ A Duplicate Copy Of This Sheet Is Enclosed.

Respectfully submitted,

COLIN BEVERIDGE et al

By:

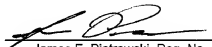
  
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I, hereby certify that this correspondence is being deposited on the date given below with the United States Postal  
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Date: November 1, 2001

  
James E. Piotrowski, Reg. No. 43,860

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re International Patent Application of:  
Colin BEVERIDGE et al.

International Application No.: PCT/GB99/03485

International Filing Date: 10/21/1999

Priority Date: 10/23/1998

For: NONWOVEN FOR POLYMER MOULDING APPLICATIONS

Commissioner For Patents  
Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

Applicant respectfully requests entry of the following Amendment to the above referenced International Application (as amended on 11/14/2000) prior to calculation of the fees and prior to examination.

In the claims:

1. A nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and further comprising at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, the treating agent comprising [wherein] an [the] active-ingredient level [in the treating agent amounts to] of at least 3% by weight of the solids in the untreated composite.
2. A nonwoven composite according to claim 1 wherein the nonwoven web comprises at least one of polyester fibers, polyolefin fibers or polyamide fibres [or a mixture of two or more such fibres].

3. A nonwoven composite according to claim 1 [or 2] wherein the nonwoven web is formed by carding and subsequent needling or by hydroentanglement.
4. A nonwoven composite according to claim 1 [or 2] wherein the nonwoven web is spunbonded material.
5. A nonwoven composite according to [any of claims] claim 1 [to 4] wherein the basis weight of the nonwoven web is [from] in the range of 20 gm<sup>-2</sup> to 150 gm<sup>-2</sup>.
6. A nonwoven composite according to [any of claims] claim 1 [to 5] wherein the second fibrous layer is formed from a pulp of cellulosic fibres.
8. A nonwoven composite according to claim 7 [which comprises, as] wherein the vegetable fibres[, ] comprise abaca, jute, sisal or a mixture thereof.
9. A nonwoven composite according to [any of claims] claim 1 [to 8] wherein the second fibrous layer is formed by an airlaying process or a wetlaying process.
10. A nonwoven composite according to [any of claims] claim 1 [to 9] wherein the basis weight of the second fibrous layer is [from] in the range of 20 gm<sup>-2</sup> to 70 gm<sup>-2</sup>.
11. A nonwoven composite according to [any of claims] claim 1 [to 10] wherein the textile-treating agent [is] comprises at least one of a siloxane polymer, a siloxane copolymer[, ] or an organofunctional siloxane [or a mixture of two or more of these].
12. A nonwoven composite according to [any of claims] claim 1 [to 11 which] wherein the treating agent comprises 3 to 7% by weight of silicone [treating agent, as silicone,] relative to the total dry weight of fibres.

13. A nonwoven composite according to claim [12 which] 1 wherein the treating agent comprises 3.5 to 6.5%[,] by weight of silicone [treating agent, as silicone,] relative to the total dry weight of fibres.

14. A nonwoven composite according to claim [13 which] 1 wherein the treating agent comprises 4 to 5.5%[,] by weight of silicone [treating agent, as silicone,] relative to the total dry weight of fibres.

15. A process for the production of a nonwoven composite in which a second fibrous layer is hydroentangled into a first fibrous layer that is in the form of a nonwoven web, and the [resultant structure is] entangled layers are treated with at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, wherein [the] an active-ingredient level in the treating agent amounts to at least 3% by weight of the solids in the untreated composite.

16. A process according to claim 15 for the production of a nonwoven composite [according to any of claims 2 to 14] wherein the treating agent comprises 3 to 7% by weight of silicone relative to the total dry weight of fibres.

17. A nonwoven composite according to claim 1, further [An article] comprising a moulded body[,] and a decorative facing material [and], wherein the nonwoven composite is disposed between [them, a nonwoven composite according to any of claims 1 to 14 or a nonwoven composite produced by a process according to claim 15 or 16] the moulded body and the decorative facing material to form an article.

18. [A moulded] An article[,] according to claim 17, wherein a form layer is disposed between the decorative facing material and the nonwoven composite.

19. A method of manufacturing an article in which a decorative facing material is placed within a mould [space], a nonwoven material is located adjacent said facing material on [the] a side remote from [the] a show surface of the facing material and a thermoplastic resin is introduced into [the] a space defined by [the] a mould wall and [the] a surface of the nonwoven material remote from the [decorative] facing material, wherein the nonwoven material [is a composite according to any of claims 1 to 14 or a composite produced by a process according to claim 15 or 16] comprises a nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and further comprises at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, the treating agent comprising an active-ingredient level of at least 3% by weight of the solids in the untreated composite.

Add the following claim:

--20. A nonwoven composite comprising a first nonwoven layer of fibers overlaid by a second nonwoven layer of fibers, at least some of the fibers of the second layer being entangled with the fibers of the first layer, the nonwoven composite further including a treating agent comprising 3 to 7% by weight of silicone relative to the total dry weight of fibres, wherein the nonwoven composite has a dry grain value within 25% of a dry grain value of the first layer by itself.--

#### REMARKS

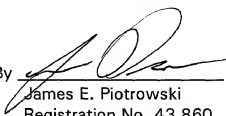
Claims 1-20 are pending in the application. Claim 20 has been added. No claims have been canceled. Claims 1-6 and 8-19 have been amended. The amendments to claims 3,4 and 6 are for the purpose of eliminating multiple dependencies to reduce fees. Accordingly, Applicants assert that the amendments to claims 3,4 and 6 do not constitute a narrowing within the meaning of Festo Corp. v.

Shoketsu Kinzoku Kogyo Kabushiki Co., 56 USPQ2d 1865 (Fed. Cir. 2000). Upon entry of the amendment, claims 1-20 will be pending in the application.

Respectfully submitted,

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U.S. Patent and Trademark Office - Civil Division - Office of the Assistant Commissioner for Trademark



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1. A nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and further comprising at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, the treating agent comprising an active-ingredient level of at least 3% by weight of the solids in the untreated composite.
2. A nonwoven composite according to claim 1 wherein the nonwoven web comprises at least one of polyester fibers, polyolefin fibers or polyamide fibres.
3. A nonwoven composite according to claim 1 wherein the nonwoven web is formed by carding and subsequent needling or by hydroentanglement.
4. A nonwoven composite according to claim 1 wherein the nonwoven web is spunbonded material.
5. A nonwoven composite according to claim 1 wherein the basis weight of the nonwoven web is in the range of 20 gm <sup>-2</sup> to 150 gm <sup>-2</sup>.
6. A nonwoven composite according to claim 1 wherein the second fibrous layer is formed from a pulp of cellulosic fibres.
8. A nonwoven composite according to claim 7 wherein the vegetable fibres comprise abaca, jute, sisal or a mixture thereof.
9. A nonwoven composite according to claim 1 wherein the second fibrous layer is formed by an airlaying process or a wetlaying process.

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10. A nonwoven composite according to claim 1 wherein the basis weight of the second fibrous layer is in the range of  $20 \text{ gm}^{-2}$  to  $70 \text{ gm}^{-2}$ .

11. A nonwoven composite according to claim 1 wherein the textile-treating agent comprises at least one of a siloxane polymer, a siloxane copolymer or an organofunctional siloxane.

12. A nonwoven composite according to claim 1 wherein the treating agent comprises 3 to 7% by weight of silicone relative to the total dry weight of fibres.

13. A nonwoven composite according to claim 1 wherein the treating agent comprises 3.5 to 6.5% by weight of silicone relative to the total dry weight of fibres.

14. A nonwoven composite according to claim 1 wherein the treating agent comprises 4 to 5.5% by weight of silicone relative to the total dry weight of fibres.

15. A process for the production of a nonwoven composite in which a second fibrous layer is hydroentangled into a first fibrous layer that is in the form of a nonwoven web, and the entangled layers are treated with at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, wherein an active-ingredient level in the treating agent amounts to at least 3% by weight of the solids in the untreated composite.

16. A process according to claim 15 for the production of a nonwoven composite wherein the treating agent comprises 3 to 7% by weight of silicone relative to the total dry weight of fibres.

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17. A nonwoven composite according to claim 1, further comprising a moulded body and a decorative facing material, wherein the nonwoven composite is disposed between the moulded body and the decorative facing material to form an article.

18. An article according to claim 17, wherein a form layer is disposed between the decorative facing material and the nonwoven composite.

19. A method of manufacturing an article in which a decorative facing material is placed within a mould, a nonwoven material is located adjacent said facing material on a side remote from a show surface of the facing material and a thermoplastic resin is introduced into a space defined by a mould wall and a surface of the nonwoven material remote from the facing material, wherein the nonwoven material comprises a nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and further comprises at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, the treating agent comprising an active-ingredient level of at least 3% by weight of the solids in the untreated composite.

20. A nonwoven composite comprising a first nonwoven layer of fibers overlaid by a second nonwoven layer of fibers, at least some of the fibers of the second layer being entangled with the fibers of the first layer, the nonwoven composite further including a treating agent comprising 3 to 7% by weight of silicone relative to the total dry weight of fibres, wherein the nonwoven composite has a dry grain value within 25% of a dry grain value of the first layer by itself.

NONWOVEN FOR POLYMER MOULDING APPLICATIONS*Field of the invention*

- 5           The present invention relates to a nonwoven composite, to a process for the production of such a nonwoven composite and to its use as a lining between the body of a moulded article and a decorative facing material borne by the said body.

*Background to the invention*

10

- Moulded forms made from thermoplastic polymers have been used for many years as decorative or infill articles, for instance panels, in automotive vehicles, domestic appliances, and the like. Such panels and like components originally had just the polymeric surface itself as the outer face and may have been textured to give a decorative effect. Recently there has been a trend towards laminating a decorative material to the outer surface of the polymer form to improve the effect. These decorative materials can, for example, be textiles, nonwovens or decorative thermoplastic olefin (TPO) films or skins.

- 20           The trend to providing these moulded forms with decorative surfaces has been particularly strong in the automotive industry in order to match the consumer demand for more "luxurious" interiors; as a result, these decorative moulded components are now common features as door linings, door pillars, dashboard elements, and the like. Additionally, a foam layer, typically polypropylene or polyurethane, may be introduced between the decorative layer and the body of the article; this technique is particularly used when the component is required to feel soft to the touch.

- 30           In the production of these moulded components there has been a move to applying the decorative surface to the moulded form during the moulding process itself rather than laminating the decorative material to the moulded form as an additional process step after the moulding process; this has cost and productivity advantages. Examples of the moulding techniques used can be found in, for example, F. Beckmann *et al.*, "Fabric back injection: from special process to mass production", *Proceedings of*

VDI *Plastics in Automotive Engineering Conference*, Mannheim (March 1998); I. Adcock, "The pressure is on for a new mold", *Automotive & Transportation Interiors* (May 1997); and United States Patent 5 543 094 (Hara *et al.*). The teaching in these documents is incorporated herein by reference.

5

A particular problem in the one-step processes is that, because of the temperatures and pressures used, the decorative surface material can be degraded by being compressed (a textile will be flattened and lose its natural nap, for example) or the thermoplastic polymer used for the body of the form can exude into the decorative surface. If a foam layer is included in the article then this too can be degraded in the moulding process.

The Hara *et al.* patent suggests that these effects can be reduced or eliminated by providing a nonwoven lining between the thermoplastic form and the decorative surface, in this case a fabric. However, the use of needled or spunbonded nonwoven linings as exemplified in the Hara *et al.* patent may still not protect the decorative material adequately because of the inherent non-uniformity of nonwoven fabrics produced by these methods. The nature of the surface of these nonwovens can also create uneven flow patterns within the thermoplastic polymer from which the body of the form is moulded; the surface pattern inherent in these nonwovens can be imposed on the decorative layer.

### ***Summary of the invention***

In a first aspect, the present invention provides a nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and further comprising a textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, wherein the actives level of the treating agent amounts to at least 3% by weight of the solids in the untreated composite.

30

In a second aspect, the present invention provides a process for the production of a nonwoven composite in which a second fibrous layer is hydroentangled into a first fibrous layer that is in the form of a nonwoven web, and the resultant structure is treated

with a textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds.

In a third aspect, the present invention provides an article comprising a moulded  
 5 body, a decorative facing material and, disposed between them, a nonwoven composite according to the said first aspect of the invention or a nonwoven composite prepared by a process according to the said second aspect of the invention.

In a fourth aspect, the present invention provides a method of manufacturing an  
 10 article in which a decorative facing material is placed within a mould space, a nonwoven material is located adjacent said material on the side remote from the show surface of the facing material and thermoplastic resin is introduced into the space defined by the mould wall and the surface of the nonwoven material remote from the decorative facing material, wherein the nonwoven material is a composite according to  
 15 the said first aspect of the invention or a nonwoven composite prepared by a process according to the said second aspect of the invention.

#### *Description of exemplary embodiments of the invention*

20 According to the invention, a nonwoven material is used as a lining between (i) a decorative surface or facing material (e.g. a fabric or film) and, if included, a foam layer, and (ii) the thermoplastic polymeric body of a moulded article. The decorative fabric, film or other facing material and, if included, the foam layer are introduced into the mould before the thermoplastic polymer and are thus laminated to the body of the  
 25 article during the moulding process.

It has now been found that the inherent non-uniformity of the types of nonwovens used as linings in the prior art can be satisfactorily overcome by a process whereby cellulosic and/or other fibres are entangled into a nonwoven and by the nature  
 30 of the process fill in the nonuniformities.

In certain preferred embodiments of the process a web of cellulosic fibres is hydroentangled into a base or substrate comprising, or consisting essentially of, a

nonwoven web which can, for example, be needlepunched, spunbonded or itself hydroentangled (often termed spunlaced). At this stage the nonwoven/cellulosic web composite (which may also be referred to as a complex or laminate) will be stronger than the original nonwoven but will have lower elongation characteristics and will be more anisotropic, that is the ratio of the cross direction (CD) strength to the machine direction (MD) strength will be less. This ratio, with the CD strength expressed as a percentage of the MD strength, is termed grain. The higher the grain the more isotropic the material. The reduction in elongation and increase in anisotropy that result from the hydroentangling process cause a reduction in moulding performance of the nonwoven in that it cannot stretch so much and cannot adapt itself to the complex shapes of the mould.

However, it has now been further discovered that by treating the nonwoven complex with a textile-treating agent, in particular from the group commonly used as hydrophilic finishes or softening agents, such as a silicone from the group commonly used as softening agents, the properties of the original nonwoven can be restored, or largely so, such that after treatment the elongation characteristics and the isotropy increase to levels that give good moulding performance.

The advantages of the treated, especially silicone-treated, nonwoven complex are several:

- The cellulose or other "second" layer, by "filling in" the structure of the nonwoven base, can give superior protection against polymer penetration and can reduce or eliminate polymer strike-through defects.
- The cellulose or other "second" layer provides a thermal barrier so that the outer decorative fabric, film or other facing material and, if included, foam layer are less affected by heat from the moulding process.
- The incorporation of cellulose and/or other fibres into the nonwoven base can reduce the "memory effect" such that the nonwoven complex shows little or no tendency to shrink or regress to its original dimensions and shape after moulding is complete.

- The cellulose or other "second" layer can also provide an excellent laminating surface so that very smooth surfaces can be achieved with the decorative layer and the surface pattern of the original nonwoven is not transferred to the decorative layer.
- 5 • The silicone or other textile-treating agent, by increasing elongation and allowing fibres to slip against each other, can enhance moulding performance.
- The silicone or other textile-treating agent may act as a lubricant to the thermoplastic polymer flow by reducing surface friction and also polymer shear, as may occur, for instance, at the injection point. This could allow the moulding of  
10 larger parts than has been possible with prior art materials.

The first fibrous layer, which may be regarded as the base layer or substrate, is generally formed of fibres of a synthetic polymer (or mixture of synthetic polymers). A suitable nonwoven web can be produced, for example, from a carded web of polyester  
15 (e.g. polyethylene terephthalate), polyamide (e.g. poly(hexamethylene adipamide) or polycaproamide, or nylon) or polyolefin (preferably polypropylene) fibres, which can be needlepunched or hydroentangled; or a spunbonded web, e.g. produced from any of the said polymers, can be used. As another alternative, the base layer can be formed from a wet-formed nonwoven, e.g. one made from any of the said polymers. Mixtures  
20 of different fibres can, of course, be used. Preferably, the nonwoven web has a basis weight (grammage) of from 20 g/m<sup>2</sup> to 150 g/m<sup>2</sup>.

The second fibrous layer can be wetlaid or airlaid: it can be deposited as a preformed layer onto the first nonwoven layer, although the formation of the second  
25 layer *in situ* on the nonwoven layer, e.g. by deposition of the fibres from a slurry, may come into consideration. Suitable second layers may be formed from pulps of cellulosic fibres, such as wood fibres, or vegetable fibres, e.g. abaca, sisal or jute fibres. Woodpulp is preferred. However, the second layer may comprise or consist of synthetic fibres, especially such fibres of good thermal stability, e.g. polyaramid fibres (such as  
30 those obtainable under the trade names "Kevlar" and "Nomex"); polyamide fibres, such as poly(hexamethylene adipamide) or polycaproamide (e.g. nylon fibres); or rayon fibres. Mixtures of different fibres can, of course, be used. Preferably, the second layer has a basis weight (grammage) of from 20 g/m<sup>2</sup> to 70 g/m<sup>2</sup>.



The fibre characteristics, such as fibre length and denier, will generally be chosen so as to provide webs with good uniformity. Typically, fibre lengths of 10-150 mm, e.g. 20-130 mm, may be used for the first layer. In the second layer, fibre lengths may typically be up to 25 mm, e.g. 2-5 mm, for cellulosic pulp fibres and typically 3 to 25 mm for synthetic fibres. Fibre deniers are preferably low, typically 0.5-6 denier (0.56-6.67 dtex) in the first layer and typically 0.1-3 denier (0.11-3.33 dtex) in the second layer.

Prior to the juxtaposition of the second fibrous layer the nonwoven web serving as the first fibrous layer may optionally be cross-stretched or tenterd by up to 300 per cent of its original width (heated conditions may be required for extensive cross-stretching), more usually by 5 to 150 percent, and especially by 15 to 80 per cent. Depending on the nature of the fibres, the stretched condition may, if required, be stabilised by heat-setting the web at 150-260°C for a period of up to 10 seconds.

The hydroentanglement may be effected by conventional means, e.g. by directing jets of fluid against the upper web or layer (normally the said second layer) superimposed upon the lower web or layer (normally the said first, nonwoven layer).

Thus, the hydroentanglement may typically be carried out by passing the juxtaposed layers, supported on a foraminous belt with the second fibrous layer uppermost, and with a line speed of 5-50 m/min under one or more manifolds providing series or banks of orifices that direct jets of fluid against the said second fibrous layer. The jets are usually columnar jets of water, preferably having a velocity of 40 ms<sup>-1</sup> or higher and preferably produced under a pressure inside the manifold of 100 kPa or higher. The orifices may typically have diameters of from 0.05 to 0.25 mm, at a spacing or pitch of 0.25 to 1.5 mm. A process of this type is described in published United Kingdom patent application GB-A-2 220 010 (Nozaki *et al.*, assigned to Uni-Charm Corporation), in published European patent application EP-A-557,678 (Homonoff *et al.*, assigned to Dexter Corporation), and in United States Patent US-A-5 009 747 (Viazmensky *et al.*, assigned to Dexter Corporation), the teaching in these documents being incorporated herein by reference.

As disclosed in EP-A-557,678, the total energy input provided by the fluid jets or streams may be calculated by the formula

$$E = 0.125 \text{ YPG/bS}$$

- wherein Y = the number of orifices per linear inch of manifold width (1 inch = 25.4 mm), P = the pressure in psig (pounds per square inch gauge) of liquid in the manifold (1 psig = 6.895 kPa gauge), G = the volumetric flow in cubic feet per minute per orifice (1 cubic foot = 28.32 dm<sup>3</sup>), S = the speed of the web material under the fluid jets or streams in feet per minute (1 foot = 0.3048 m) and b = the basis weight of the fabric produced in ounces per square yard (1 ounce/yd<sup>2</sup> = 33.91 g/m<sup>2</sup>). The total amount of energy, E, expended in treating the web is the sum of the individual energy values for each pass under each manifold, if there is more than one manifold and/or if there is more than one pass. Usually, the total energy input is from 0.07 to 0.4 horsepower-hours per pound (HPhr/lb) (0.414 to 2.367 MJ/kg). Typically, however, the total energy input is less than 0.3 HPhr/lb (1.776 MJ/kg), e.g. is from 0.1 to 0.25 HPhr/lb (0.592 to 1.480 MJ/kg).

- Because the elements (webs or layers) of the complex are hydroentangled together other bonding is not required (although additional bonding is not precluded). The basic technology for hydroentanglement could, of course, be readily adapted for other arrangements. For example, it is possible to have fluid jets impinge on both sides of the composite: such an arrangement may be appropriate when the composite comprises a third fibrous layer adjacent the side of the first, base layer that is remote from the said second layer. In such a "sandwich" construction, the third layer may be similar or dissimilar to the second layer, depending on the desired overall properties of the resultant composite.

- Either or each of the layers or webs may be single-ply or formed in two or more plies.

- The hydroentangled composite, usually after it has been dried, is treated, in accordance with this invention, with a textile-treating agent (which agent may be hydrophilic). Suitable agents may be selected from the class of silicones and silicone derivatives (organosilicones), including siloxane polymers, e.g. poly(dimethylsiloxanes) (PDMS) or poly(monomethylsiloxane); siloxane copolymers (which term includes graft copolymers and block copolymers), e.g. polyether-polysiloxane copolymers (dimethicone copolyols), such as PDMS - (polyalkylene oxide) copolymer

wherein the alkylene oxide is ethylene oxide, propylene oxide or a mixture thereof; and organofunctional siloxanes, e.g. aminofunctional siloxanes. Silicones and derivatives thereof useful as textile-treating agents are known (see, for example, J.C. Salamone (ed.), *Polymeric Materials Encyclopedia*, CRC Press (1996), volume 1, page 215 *et seq.* and volume 10, page 7706 *et seq.*). Silicones useful in the treatment of tissues are also disclosed in WO-A-97/04173, page 8, line 18, to page 9, line 15. Such agents are commercially available, for example the agent marketed as OSI Nuwet 300, or Dow Coming 2-8676 (hydroxy-terminated methylaminopropyl siloxane, 20% actives, emulsion), or Dow Coming 108 (aminoethylaminopropyl dimethyl siloxane).

- 10 Other suitable textile-treating agents include quaternary ammonium compounds, e.g. tetraalkylammonium halides, imidazoline quaternaries, amidoamine quaternaries and ester-quaternaries. Quaternary ammonium compounds and their use as fabric softeners are known (see, for example, Kirk-Othmer, *Encyclopedia of Chemical Technology*, Fourth Edition, Volume 20, Wiley-Interscience (1996), page 739 *et seq.*).
- 15 Quaternary ammonium compounds useful in the treatment of tissues are also disclosed in WO-A-97/04173, page 3, line 22, to page 5, line 29. An example is Varisoft 3690 (methyl-1-oleyl amidoethyl-2-oleyl imidazolinium methylsulfate, aqueous composition, 90% actives). Other agents also come into consideration, e.g. nonionic substituted stearamides.

- 20 The treatment agent may comprise a mixture or blend of suitable compounds.

- Usually, the treatment agent is applied in the form of an aqueous composition, e.g. an aqueous solution or emulsion. The treatment agent can, for example, be applied in-line by "padding" or "size press" techniques. Preferably, the level of active ingredients in the treatment agent applied to the nonwoven composite is from 3 to 7%,
- 25 more preferably from 3.5 to 6.5% and most preferably from 4 to 5.5, by weight of the solids in the untreated composite. Thus, in certain preferred embodiments the nonwoven composite comprises 3 to 7%, more preferably 3.5 to 6.5% and most preferably 4 to 5.5%, by weight of silicone treating agent, as silicone, relative to the total dry weight of the fibres. Nuwet 300, for example, may be applied at a
- 30 concentration of, say, 80 ml/litre for 100% wet pick-up. After application of the treating agent the composite is usually dried.

The nonwoven composite of the invention may be used as a lining or protective backing for decorative elements such as textile, film or TPO skins in the low-pressure injection moulding (LPIM) or compression moulding of such articles as automotive components, e.g. interior door panels, dashboard fascia and pillars.

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Adhesive lamination or flame lamination may be used to attach the nonwoven liner to the decorative facing material (or to an intermediate foam layer, if used). Preferably, the said second layer (e.g. a cellulosic web) is located adjacent the decorative facing material (or foam layer) in order to provide a smooth surface.

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The present invention is illustrated in and by the following Examples. In these Examples, as elsewhere herein, basis weight (grammage) is measured by ISO 536 using a sample size 203 mm (8 inches) square; and tensile strength and elongation at break is measured according to ISO 1924-1.

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### *Example 1*

A carded nonwoven web of polyester, lightly bonded by needlepunching and having a basis weight of  $80 \text{ g/m}^2$ , was cross-stretched to 125% of its original width in a tenter and heat-set and was then hydroentangled to a single-ply, wetlaid cellulosic tissue having a nominal fibre length of 2 mm and a basis weight of  $39 \text{ g/m}^2$ . This complex was treated with 4.1% silicone, namely OSi Nuwet 300 Hydrophilic Finish, understood to be an amino modified silicone-polyether copolymer.

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Hydroentanglement was effected by passing the base nonwoven web with the cellulosic web superimposed upon it under ten successive manifolds having pressures within them increasing from 3 MPa to 6 MPa. Each manifold had a nozzle plate having two rows of staggered orifices, of 0.09 mm diameter with a spacing of 1 mm, which directed columnar jets of water at the upper surface of the cellulosic web. The juxtaposed webs were supported on a woven fabric, travelling at about 40 m/min, under which fabric were disposed on a series of vacuum boxes, each in register with a respective manifold, for extracting the water. After hydroentanglement, the resultant

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nonwoven composite was dried. The composite was thereafter impregnated with the silicone treating agent in a conventional size press and was dried once more.

- The dry tensile strength and the elongation at break were tested in both the machine direction and the cross direction. For comparison, the untreated complex and the needlepunched nonwoven were also tested. The test data were as follows:

Properties	Needlepunched nonwoven	Hydroentangled needlepunched nonwoven and cellulosic web	Complex treated with silicone
Dry tensile strength, MD, N/m	3,130	6,257	3,596
Dry tensile strength, CD, N/m	2,750	4,030	3,061
Dry grain, %	87.9	64.4	85.1
Elongation at break, MD, %	59	39	48.3
Elongation at break, CD, %	100	72	90.5

- It can be seen that the untreated complex is stronger but has lower elongation than the nonwoven alone but that the silicone treatment has essentially restored the original properties of the nonwoven to the complex.

### Example 2

- Using the same materials as in Example 1, except that the carded nonwoven web of polyester, lightly bonded by needlepunching, has a basis weight of 120 g/m<sup>2</sup>, and using the same silicone addition level, 4.1%, the following results were obtained.

Properties	Needlepunched nonwoven	Hydroentangled needlepunched nonwoven and cellulosic web	Complex treated with silicone
Dry tensile strength, MD, N/m	3,628	7,970	6,998
Dry tensile strength, CD, N/m	2,459	4,911	4,036
Dry grain, %	67.8	61.6	57.7
Elongation at break, MD, %	76.6	46.1	74
Elongation at break, CD, %	126	105.9	128.4

This gives similar results to Example 1 but the reduction in strength after silicone treatment is much less.

### Example 3

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Using the same materials as Example 1, except that the carded nonwoven web is of 1.6 dtex, 38 mm polyester, bonded by hydroentanglement, and has a basis weight of 45 g/m<sup>2</sup>, and using the same silicone addition level, 4.1%, the following results were obtained.

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Properties	Hydroentangled (spunlaced) nonwoven	Hydroentangled spunlaced nonwoven and cellulosic web	Complex treated with silicone
Dry tensile strength, MD, N/m	2,896	4,198	2,379
Dry tensile strength, CD, N/m	523	1,158	520
Dry grain, %	18.1	27.6	21.9
Elongation at break, MD, %	27.9	23	30.9
Elongation at break, CD, %	164.5	80.7	110.5

Similar effects are obtained with the spunlaced nonwoven precursor as with the needlepunched material.

### 15 Example 4

A base web of 28 g/m<sup>2</sup> polypropylene spunlaid nonwoven was hydroentangled to a 60 g/m<sup>2</sup> wetlaid cellulosic web (3 x 20 g/m<sup>2</sup> ply). This complex was treated with 4.1% silicone agent (OSI Nuwet 300). The test data were as follows:

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Properties	Spunlaid nonwoven	Hydroentangled spunlaid nonwoven and cellulosic web	Complex treated with silicone
Dry tensile strength, MD, N/m	1,619	2,438	1,797
Dry tensile strength, CD, N/m	901	1,618	911
Dry grain, %	55.7	66.4	50.7
Elongation at break, MD, %	86.2	43.6	59.6
Elongation at break, CD, %	129.6	75.4	106.9

Again, similar results are obtained. This construction is particularly appropriate when the interposed nonwoven complex should be lightweight.

### 5 Example 5

This is the same as Example 1 except that a range of silicone additions has been used.

Properties	Hydroentangled needlepunched nonwoven and cellulosic web complex treated with silicone		
	Silicone level	Silicone level	Silicone level
	4.1%	5%	6%
Dry tensile strength, MD, N/m	3,596	4,031	3,871
Dry tensile strength, CD, N/m	3,061	2,675	2,632
Dry grain, %	85.1	66.4	68
Elongation at break, MD, %	48.3	49.4	48.7
Elongation at break, CD, %	90.5	96.3	95.8

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With increased silicone addition, the ratio of CD strength to MD strength declines so that the product is less isotropic. When the silicone addition is increased to 6% the elongation decreases.

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It will, of course, be understood that the present invention has been described above purely by way of example and that modifications of detail can be made within the scope of the invention.

CLAIMS

1. A nonwoven composite comprising a first fibrous layer in the form of a nonwoven web to which a second fibrous layer is joined by fibre entanglement and  
5 further comprising at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, wherein the active-ingredient level in the treating agent amounts to at least 3% by weight of the solids in the untreated composite.
- 10 2. A nonwoven composite according to claim 1 wherein the nonwoven web comprises polyester, polyolefin or polyamide fibres or a mixture of two or more such fibres.
3. A nonwoven composite according to claim 1 or 2 wherein the nonwoven web is  
15 formed by carding and subsequent needling or by hydroentanglement.
4. A nonwoven composite according to claim 1 or 2 wherein the nonwoven web is a spunbonded material.
- 20 5. A nonwoven composite according to any of claims 1 to 4 wherein the basis weight of the nonwoven web is from  $20 \text{ gm}^{-2}$  to  $150 \text{ gm}^{-2}$ .
6. A nonwoven composite according to any of claims 1 to 5 wherein the second fibrous layer is formed from a pulp of cellulosic fibres.
- 25 7. A nonwoven composite according to claim 6 wherein the cellulosic fibres are wood fibres, vegetable fibres or a mixture thereof.
8. A nonwoven composite according to claim 7 which comprises, as vegetable  
30 fibres, abaca, jute, sisal or a mixture thereof.
9. A nonwoven composite according to any of claims 1 to 8 wherein the second fibrous layer is formed by an airlaying or wetlaying process.



10. A nonwoven composite according to any of claims 1 to 9 wherein the basis weight of the second fibrous layer is from 20 gm<sup>2</sup> to 70 gm<sup>2</sup>.
- 5 11. A nonwoven composite according to any of claims 1 to 10 wherein the textile-treating agent is a siloxane polymer, a siloxane copolymer, an organofunctional siloxane or a mixture of two or more of these.
12. A nonwoven composite according to any of claims 1 to 11 which comprises 3 to 7% by weight of silicone treating agent, as silicone, relative to the total dry weight of fibres.
- 10 13. A nonwoven composite according to claim 12 which comprises 3.5 to 6.5%, by weight of silicone treating agent, as silicone, relative to the total dry weight of fibres.
- 15 14. A nonwoven composite according to claim 13 which comprises 4 to 5.5%, by weight of silicone treating agent, as silicone, relative to the total dry weight of fibres.
- 15 15. A process for the production of a nonwoven composite in which a second fibrous layer is hydroentangled into a first fibrous layer that is in the form of a nonwoven web, and the resultant structure is treated with at least one textile-treating agent selected from silicones, derivatives of silicones and quaternary ammonium compounds, wherein the active-ingredient level in the treating agent amounts to at least 3% by weight of the solids in the untreated composite.
- 20 25 16. A process according to claim 15 for the production of a nonwoven composite according to any of claims 2 to 14.
17. An article comprising a moulded body, a decorative facing material and, disposed between them, a nonwoven composite according to any of claims 1 to 14 or a nonwoven composite produced by a process according to claim 15 or 16.
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18. A moulded article, according to claim 17, wherein a foam layer is disposed between the decorative facing material and the nonwoven composite.

19. A method of manufacturing an article in which a decorative facing material is placed within a mould space, a nonwoven material is located adjacent said material on the side remote from the show surface of the facing material and thermoplastic resin is introduced into the space defined by the mould wall and the surface of the nonwoven material remote from the decorative facing material, wherein the nonwoven material is a composite according to any of claims 1 to 14 or a composite produced by a process according to claim 15 or 16.

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0010/PTO Rev. 6/95	U.S. Department of Commerce Patent and Trademark Office	Attorney Docket	DEXNON/110/PC/US
		First Named Inventor	COLIN BEVERIDGE
COMPLETE IF KNOWN			
<b>DECLARATION</b>		Application Number	
<input checked="" type="checkbox"/> Declaration Submitted With Initial Filing	<input type="checkbox"/> Declaration Submitted After Initial Filing	Filing Date	
		Group Art Unit	
		Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**NONWOVEN FOR POLYMER MOULDING APPLICATIONS**

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ Was filed on (MM/DD/YYYY) 10/21/1999 as United States Application or PCT International Application Number PCT/GB 99/03485 and was amended on (MM/DD/YYYY) 11/14/2000.

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Codes of Federal Regulations, §1.56.

I hereby claim foreign priority under Title 35, United States Code § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Numbers	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Copy Attached Yes No
98308712.3	EP	10/23/98	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

☐ Additional Foreign Application Numbers Are Listed On A Supplemental Priority Sheet Attached Hereto:

I hereby claim the benefit under Title 35, United States Code § 119 (e) of any United States provisional application(s) listed below:

Application Number(s)	Filing Date (MM/DD/YY)	
NONE		<input type="checkbox"/> Additional Provisional Application Numbers Are Listed On A Supplemental Priority Sheet Attached Hereto.

